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Constructibility Review Procedures

Constructibility and Design Reviews: Analysis and Recommendations for Improvement

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Constructibility and design reviews at the early stages of a construction project are critical to controlling time and cost growth. These reviews identify omissions, ambiguities, and inadequacies in the design, reducing contract modifications and change orders during the construction phase and thus minimizing cost overruns. In addition, proper review can contribute to low operating and maintenance costs throughout the facility service life and encourage value engineering options that might not otherwise be considered.

To improve its review process, the U.S. Army Corps of Engineers asked the U.S. Army Construction Engineering Research Laboratory (USACERL) to investigate the existing procedures and recommend remedial actions. The response has been a 5-year effort by USACERL to identify weaknesses in the current system and develop management principles and techniques to optimize reviews. In general, it was found that the volume of comments to be handled, the reviewers' other workload, and the number of construction projects were making manual review management inefficient. Therefore, USACERL proposed development of an automated system to assist reviewers and project managers in tracking and documenting reviews. The ultimate product of this research is the Automated Review Management System (ARMS), which has been field-tested and is ready for implementation.

This report describes the research and development forming the basis for the ARMS concept. Two other USACERL reports describe the field-testing and use of ARMS (a Draft Technical Report and ADP Report P-87/08).

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Constructibility and design reviews at the early stages of a construction project are critical to controlling time and cost growth. These reviews identify omissions, ambiguities, and inadequacies in the design, reducing contract modifications and change orders during the construction phase and thus minimizing cost overruns. In addition, proper review can contribute to low operating and maintenance costs throughout the facility service life and encourage value engineering options that might not otherwise be considered.

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This report describes the research and development forming the basis for the ARMS concept. Two other USACERL reports describe the field-testing and use of ARMS (a Draft Technical Report and ADP Report P-87/08).

FOREWORD

This research was conducted for the Directorate of Engineering and Construction, Headquarters, U.S. Army Corps of Engineers (HQUSACE), under Project 4A162734AT41, "Military Facilities Engineering Technology"; Work Unit BO-038, "Constructibility Review Procedures." The HQUSACE Technical Monitor was S. Green, CEEC-CE.

The investigation was performed by the U.S. Army Construction Engineering Research Laboratory (USACERL) Facility Systems Division (FS). Dr. Michael J. O'Connor is Chief of FS. The USACERL technical editor was Dana Finney, Information Management Office.

COL Carl O. Magnell is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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CONSTRUCTIBILITY AND DESIGN REVIEWS: ANALYSIS AND RECOMMENDATIONS FOR IMPROVEMENT

1 INTRODUCTION

Background

Control of time and cost growth is paramount to the successful delivery of military construction projects. Many problems related to time and cost growth result from errors or inadequacies in the contract documents. Review processes for technical design and Biddability, Constructibility, and Operability (BCO), as well as functional reviews conducted by the end users are required by the U.S. Army Corps of Engineers (USACE) during the design phase to aid in detecting omissions, ambiguities, and inadequacies in the design. This effort substantially reduces contract modifications and change orders during the construction phase. In addition, proper review can contribute to reduced maintenance and operating costs throughout the life of the facility and stimulate value engineering initiatives. Finally, architect/engineering (A/E) firms benefit from this effort: their liability is reduced because the rigorous design reviews lower the risk of errors and omissions (E&O) claims against them.

The establishment of a formal design review program to be conducted by qualified professionals is the most effective means of identifying deficiencies and incorporating improvements into the construction documents. Such a program is mandated for most military construction projects. USACE recognizes that the maximum potential for design reviews in general and BCO reviews in particular is realized when these reviews are conducted early in the conceptual design stage and diminishes as the design effort proceeds toward completion.[1]

In FY83, USACE asked the U.S. Army Construction Engineering Research Laboratory (USACERL) to study ways of improving the construction review process. This report documents USACERL's 5-year effort, which has culminated in development of the Automated Review Management System (ARMS).

Purpose

The purpose of this work is to analyze the USACE Constructibility Review Program and recommend actions for improving it.

Approach

The challenge presented to USACERL was to examine and improve the USACE Constructibility Process; the primary objective at the outset was to improve the governing Engineering Regulation (ER 415-1-11).[2] The approach taken was to first study and

[1]B. C. Paulson, "Designing to Reduce Construction Costs," *J. Constr. Div., ASCE*, Vol 102(CO4) (1976), p 587-592.

[2]Engineering Regulation (ER) 415-1-11, *Biddability, Constructibility, and Operability* (Headquarters, U.S. Army Corps of Engineers [HQUSACE], 1 June 1984).

fully define the problem through a questionnaire and field visits to three District offices in FY83 and FY84. These fact-finding efforts identified several areas that needed improvement. A workshop was held at USACERL during FY84* to discuss these issues and identify the appropriate actions. A three-phased approach was developed as a result of that workshop: (1) revise ER 415-1-15, (2) draft a command emphasis letter for the Chief of Engineers to send to the field, and (3) examine automation tools to assist with the process. The first two actions were completed in FY84 and development of automation support was also initiated. At this time, it was recognized that the problem was actually broader than just BCO reviews and that what was actually needed was a management system for all types of reviews. A conceptual design review management system was developed and briefed to several Districts for comment.

ARMS Version 1.0 (a concept test program) was developed in the latter half of FY85 and delivered to Omaha District in January 1986 for pilot testing. A steering committee review at the end of the FY86 test identified the performance requirements for a prototype ARMS 2.0. Version 2.0 was developed and delivered to the FY87 test Districts (Sacramento, Savannah, and Omaha)[3]. Review of test results provided the performance characteristics for the fieldable version of ARMS 3.0, which was ready for delivery in early FY89.

Scope

Results of the inquiries into the BCO process, although conducted in FY83 and FY84, still apply to Districts that have not yet installed an automated review management system like ARMS. Although the initial focus was limited to BCO activities, it was found that the observations are appropriate to all design review activities. This report focuses on the research and development that formed the conceptual basis for ARMS. A USACERL Draft Technical Report describes the field test of ARMS as part of the Technology Transfer Test Bed (T^3B) program.[4]

Mode of Technology Transfer

The result of this research has been the development of ARMS. The system and underlying principles resulting from this research are being transferred to the field through hands-on experience, tutorial, online assistance, a user's group, and periodic workshops.

Since it appears that ARMS or a similiar system will become a USACE standard, the information in this report will be useful to all field operating activities that conduct design reviews. Also, since civil design review activities are similar to the military's, information in this report is equally applicable to civil works design projects.

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*Appendix A lists attendees.

[3]J. Kirby, D. Hicks, D. Furry, and J. Koenke, *Automated Review Management System*, ADP Report P-87/08 (U.S. Army Construction Engineering Research Laboratory [USACERL], January 1987).

[4]J. Kirby, *Field Test of the Automated Management Review System (ARMS)*, Draft Technical Report (USACERL, January 1989).

2 STATUS OF MANUAL DESIGN REVIEW ACTIVITIES

Need for Design Reviews

The process of reviewing construction documents for accuracy, completeness, and correctness is widely recognized as integral to the proper execution of professional design services. These reviews should be done by the designer of record to detect and correct errors, omissions, and technical deficiencies, and are motivated by the desire to minimize the firm's liability exposure. Reviews by private sector clients or end users to verify the design's functional compliance are often less formal and may consist of little more than "signing-off" on the designer's efforts. Reviews by constructors to discover interface problems, resolve conflicts between the contract documents and existing site conditions, or identify potential savings through methods improvements are seldom conducted in the private sector except on large industrial construction, design-build ventures, or force account work.

A survey conducted by USACERL in FY83 and a study by Mogren in 1986[5] have identified three major causes of contract modifications: (1) design deficiencies; (2) user-requested changes; and (3) unknown site conditions. The USACERL study found that 56 percent of all contract modifications are to correct design deficiencies. This evidence suggests the need for improvements in the efforts of all participants towards early identification and resolution of potential problems so as to deliver a complete, correct set of contract documents to the constructor.

USACE has long recognized the potential for savings implicit in a program of formal design review and has therefore mandated that such programs be incorporated into the design phase of all military construction programs. As the construction agency for both the Army and the Air Force, USACE assumes primary responsibility for delivery of acceptable facilities to its client service branches. Considering the estimated $6 billion volume of construction placed yearly, even a modest 1 to 3 percent reduction in project cost achievable through effective review procedures results in a significant potential yearly savings. However, a publication prepared by the Construction Industry Institute suggests that savings on the order of 6 to 23 percent of the original estimate are achievable through proper constructibility review.[6] The USACE design review processes include technical and functional as well as BCO reviews. Each USACE review activity is defined below.

Constructibility Review

ER 415-1-11 defines constructibility as "the compatibility of the design with the site, materials, methods, techniques, schedules, and field conditions." Constructibility encompasses issues such as: (1) ease of construction; (2) enhancement of contractor productivity; (3) adaptation of design structures and features to site conditions and restrictions; and (4) tradeoffs between standard components versus custom-designed and

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[5] MAJ Eric T. Mogren, *The Causes and Costs of Modifications to Military Construction Contracts* (U.S. Army Command and General Staff College, Fort Leavenworth, KS, 1986).

[6] *Constructibility: A Primer*, Publication 3-1 (Construction Industry Institute, Austin, TX, July 1986), pp 6-12.

fabricated ones. Field construction personnel must complete this review at concept (35 percent) and final (95 percent) phases for each project.

Biddability Review

Biddability pertains to the ease with which the contract documents can be understood, bid, administered, and enforced. Topics relevant to biddability are: (1) sufficiency and accuracy of details; (2) elimination of design errors, omissions, and ambiguities; and (3) clarity, simplicity, and completeness of contract documents.

Operability Review

Operability refers to the ease with which a facility can be operated and maintained. Issues pertaining to operability include: (1) life-cycle costs of surfaces, fixtures, components, and systems; (2) architectural compatibility with existing facilities and established master plans; and (3) adequacy of size and configuration of proposed facilities for their expected function. The operability review is conducted by Directorate of Engineering and Housing (DEH) personnel for Army projects and by the Base Civil Engineering staff for Air Force projects.

Functional Review

The facility end user must perform a functional review of the design documents. Topics typically covered in this review focus on the selection of exterior and interior finishes, room layout and relational setting, and sizing.

Technical Review

USACE in-house design professionals review design submittals to ensure that design standards are met and the design documents specify the desired level of quality for the completed project.

Results of USACE-Wide BCO Questionnaire

During FY83, USACERL solicited responses to a questionnaire on constructibility review. A total of 299 completed questionnaires were returned. This section summarizes the findings. The questionnaire is reproduced as Appendix B.

Scope of Problem

Two-thirds of the respondents (64 percent) felt the occurrence of design deficiencies could be classified as "somewhat excessive" or "excessive." The same percentage stated that the number of contract modifications are "somewhat excessive" or "excessive." This correlation between design deficiencies and contract modification was supported by the belief that 56 percent of all contract modifications are to correct design deficiencies. Respondents were equally divided on whether the number of modifications influences the quality of workmanship or not.

Numerous comments stated that construction contract award date is rarely changed even if significant design deficiencies are known. Causal factors were not often cited except to note that external constraints often set award dates. Political considerations often were cited as the reason for inflexible award date. For some civil works jobs, the length of the construction season may dictate the required award date. In any case, the general consensus was that the current USACE priority is on meeting the award date-not the quality of the bid package.

Current Constructibility Review Methodology

ER 415-1-11, according to 81 percent of the respondents, has improved the quality of plans and specifications. This view is supported by the fact that 88 percent of the USACE Divisions/Districts have issued some guidance to implement constructibility review. Corps-wide constructibility reviews are required for 88 percent of all projects. Responsibility for the constructibility review is typically assumed by the Construction Division (60 percent of the time). This assignment, however, is only a full-time responsibility 31 percent of the time. Only occasionally is a central constructibility coordinator appointed. Normally, two design reviews are held: the first between 35 and 60 percent completion and the second between 90 and 100 percent completion. Records of these reviews are normally kept but the results of follow-up actions are not always furnished to the submitter ("always" was the response from only 14 percent; 70 percent "usually" or "sometimes").

For most projects (64 percent of the time), 10 working days or less are allocated for constructibility review and submittal of comments. Since the drawings and specifications are typically completed only 19 days prior to award, often only 9 days (19 - 10) are available to correct errors. It was reported that completed drawings are sometimes not available for constructibility review until the Invitation for Bid (IFB) is issued. Clearly, the ability to amend or reissue plans and specifications during this period is hampered. This shortage of time to correct known errors was reflected in response to another question, indicating that in only 3 percent of the time are projects advertised with no known discrepancies in the plans and specifications. It is rare that a bid period is postponed because of an incomplete/incorrect bid package.

Field construction offices are normally invited to participate in less than one-half (49 percent) of the constructibility reviews even though it was recognized by 77 percent of respondents that participation enhances field decision-making ability. Some Districts use the constructibility review process as the last design review. This practice should never be done; the constructibility review is meant to be a last check prior to construction award--not the last design review.

Field and District personnel frequently stated that design jobs are routinely awarded to known marginal A/Es. In addition, USACE does not enforce A/E liability claims. This leniency does not cause the marginal A/E to improve and, in a sense, penalizes the A/E with a good performance record; that is, no reward is apparent to offset the firm's effort to produce a quality design.

Constructibility Review Effectiveness

The overall perception was that constructibility review is beneficial. Only a small percentage of the Districts (13 percent), however, keep "before" versus "after" statistics. Those which do reported a 76 percent reduced occurrence of deficiencies in the contract documents. Most Districts (61 percent) reported additional manpower is

required to achieve the full benefits of constructibility review. Performance of constructibility reviews was said to be hampered by late submittal of the plans and specifications and lack of centralized controls over the review process. In addition, there was a reported lack of follow-up on constructibility comments currently submitted.

Quality of Contract Documents

According to respondents, USACE is not making effective use of the A/Es that do design work. The most frequently recommended improvement (76 percent) was that the A/Es be held liable for correcting their mistakes. Two-thirds (65 percent) also felt that USACE should do a better job reviewing A/E products, and 54 percent of the recommendations were to provide better guidance. Guide specifications are often used "as is" and not tailored to the particular application.

Almost 73 percent favored constructibility review as outlined in ER 415-1-11 and felt significant improvements could be made if it were implemented without constraints. Field participation was viewed as a benefit by 77 percent. Almost all agreed (96 percent) that discrepencies in the plans and specifications are corrected more economically prior to award.

Findings From Survey

Results of the survey have shown that:

1. In-house designers need more experience performing detailed design.

2. A definite need exists to cross-train engineering and construction personnel.

3. The USACE top priority should be to ensure a quality design--not to meet the construction award date.

4. USACE should be more selective with A/E firms; award additional work to known performers; and eliminate marginal A/Es from the bidding lists.

5. A system should be implemented to enable USACE to learn from past mistakes.

6. A major effort should be directed toward upgrading the existing USACE guide specifications.

Survey of District Constructibility Review Procedures

In FY84, constructibility review procedures were examined during site visits to three Districts: Louisville, KY; Sacramento, CA; and Baltimore, MD.

Louisville

During FY84, Louisville District performed 22 manyears of effort in constructibility review for the U.S. Environmental Protection Agency (USEPA). A report generated by USEPA identified a significant savings from constructibility reviews. The $500 - $1000 spent on each review was recovered many times in reduced change order costs. Observations of the BCO process at Louisville were similiar to those voiced in the survey: constructibility review is not typically performed by field offices at 35 percent

design; there is too little time for the review; marginal A/Es are used; and resolutions for comments are not sent to originator.

Sacramento

Sacramento District is uniquely organized to perform design review. A Design Quality Assurance Section within the Engineering Division has been formed to perform design review. This Section does all of the in-house design review as well as coordination of comments received from external sources. An in-house automation effort was underway at the time of the visit. The software program REVIEW being developed in FY84 was planned to be an electronic mail system that would route comments from field offices to the District and allow annotations to the original comment.

Baltimore

The Baltimore District Construction Division had implemented a tracking system to record the on-time return performance of reviewers as well as the response time of Engineering Division to Construction's comments. Once the tracking system was in place, the on-time response rate improved immediately from the 50 to 60 percent range to 80 percent.

Conclusions From Field Visits and Questionnaire

The conclusions obtained from the field visits were consistent with those from the questionnaire. In general, four major areas of potential improvement were identified: (1) management emphasis, (2) selection of A/Es (3) USACE communications, and (4) USACE procedures.

The field visits also showed that, besides the need to improve review process management, the performance of the design review activities could be improved. A decision was made to address the management issue first, as it had the highest immediate payoff. Field visits clearly identified the lack of effective management of the review process for a variety of reasons, with the most important being the Project Manager's large workload. A typical project review effort (Figure 1) for BCO, technical, and user functional reviews will involve two to three reviews per project and result in 600 to 1000 total comments submitted by 30 to 50 reviewers from 8 to 12 different review sections. A military project manager can have from 5 to 20 projects in design at any time, depending on size and complexity, and an average District will have 40 to 50 Project Managers (PMs) overseeing the design of 600 total projects.

Since each project has a separate time schedule, different reviewers, and varied chain of command, a typical manual tracking system, if one exists, cannot ensure that reviews are completed on time. The result is that the PM is forced to act with the information provided at the due date. Since no management system exists to report on progress, there is little incentive for reviewers to respond on time. In addition, reviewers often are never informed of the final action on their comments. This situation does not encourage them to perform at high levels on future reviews.

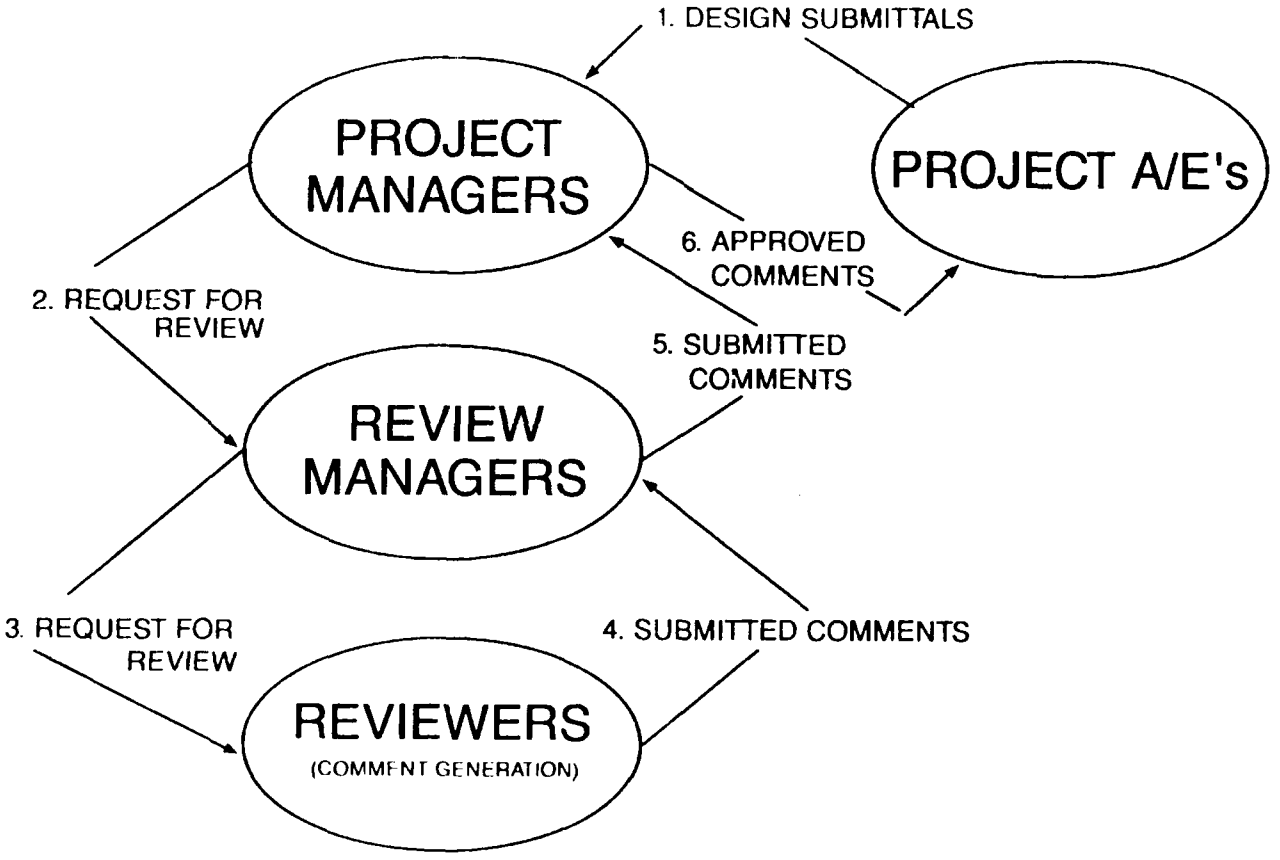

Figure 1. Typical project design review process.

3 WORKSHOP TO DISCUSS STATUS OF BCO REVIEW WITHIN USACE

In February 1984, a workshop convened at USACERL in Champaign, IL, to discuss the results of research efforts to date. Representatives from six USACE Districts participated as well as the Technical Monitor from Headquarters. The result of this workshop was a general statement of the current status of BCO review within USACE. The issues stated in Chapter 2 were further defined and clarified.

Lack of Management Emphasis

Existing ER Is Not Implemented Adequately

The current Biddability, Constructibility, and Operability regulation (ER 415-1-11) has been in effect for some time. However, it has not been enforced rigorously even though numerous Divisions and Districts have issued supplementary implementing regulations. For the most part, these supplemental regulations have neither increased nor improved the constructibility review program.

Little Effort Is Being Expended To Improve the Constructibility Review Process

Two Districts (Sacramento and Baltimore) are independently developing limited automation support. Beyond that, no other effort is being expended on developing ways to improve the review process since a low priority seems to be placed on this activity.

USACE Is Reluctant To Delay Bid Openings

Management emphasis seems to stress meeting bid opening dates at almost any cost. Most projects go to bid with known deficiencies. Very seldom is a bid delayed in order to correct a design or specification deficiency.

Senior Personnel Are Not Assigned

Success of constructibility review requires the involvement of senior personnel who have the years of experience that allow quick identification of problem areas. Typically, senior personnel are not assigned--even though a thorough constructibility review will ensure that large cost avoidance problems will be identified.

A/E Performance

Marginal Performers Are Often Selected

A/Es are evaluated only as "satisfactory" or "unsatisfactory." The "satisfactory" evaluation includes a large number of marginal performers since it is viewed as difficult to justify an unsatisfactory rating. As a result, many known marginal A/Es continue to receive new work. It has been reported that field personnel are not always involved in the A/E appraisal process. This situation is unfortunate since often the completed plans and specifications are not reviewed adequately prior to bid. Field personnel could render a good evaluation as to the quality of the design package.

USACE Does Not Provide Adequate Guidance/Review

Problems with design should be addressed early in the concept phase, not at the end via a 95 percent constructibility review. Clear statements of the desired scope of the project and desired quality of the product are not always given to the A/E. In addition, the end product often is not given an adequate review prior to bid opening. Because of this practice, many jobs are accepted that should, in fact, be returned for correction.

Plans and Specifications Are Not Completed in Time for Review

USACE does not rigorously enforce the design schedule. There is a tendency to slip the design completion date but not the bid opening date. As a result, the time available for constructibility reviews is reduced. Many field personnel report not obtaining the design packages until the same time or after bid opening.

Liability Is Not Enforced

USACE tends to accept marginal or deficient jobs and fix them in-house. This practice does little to encourage the A/E to produce a quality design package. USACE must adopt a "stand-firm" policy on design quality. A submittal date must not be judged as met if the desired quality is lacking.

Communication

Resolution of Comments Is Not Distributed

Resolutions for review comments often are not returned to the submitter. This policy discourages the performance of detailed reviews because the submitter does not receive any feedback as to why the review comments were accepted or rejected.

Lessons-Learned Mechanism Is Not in Place

A USACE-wide system to record constructibility review problem areas does not exist. Some Districts have identified problem areas to be reviewed but this information is not shared among Districts. Huntsville Division has recently made the Construction Evaluation Retrieval System (CERS) available to the Districts. Input to this system is principally via a Huntsville team. The data, which cover design and construction deficiencies discovered during actual construction projects, are not currently being used by many USACE activities.

Comments Are Not Always Understood

Many constructibility reviews are documented as written comments. Since the locally developed forms have a minimum of space for comments, the comments tend to be extremely brief. Consequently, the recipient sometimes cannot understand the exact nature of the comment.

Constructibility Review Does Not Foster Engineering and Construction Communication

A constructibility review offers the opportunity for engineering and construction personnel to work together towards a common goal--construction of a quality product within cost and schedule. However, this cooperation often does not occur. Field

engineers may not be invited to participate in constructibility reviews, which is unfortunate since early field project review is the best time to obtain site information. In addition, field evaluation of A/E performance is not solicited. During the construction process, the field normally must take an indirect route (through the District) to resolve questions. Engineers do not consider constructibility review to be part of the design process. This attitude is one reason why construction personnel often do not receive adequate time to perform a constructibility review prior to bid opening.

A Clear Definition of Constructibility Review Is Needed

Most existing regulations define the concept of constructibility review in general terms. No detailed list of activities exists (e.g., a checklist). Thus, the reviewers are left without a clear statement of tasking. This may or may not be a good idea. For the most part, the reviewers work only within their areas of expertise. Since a central coordinator of the review normally is not assigned, there is no guarantee that all portions of the design will receive the same level of review effort. A definition of what constitutes a constructibility review is needed to improve the review process.

USACE Procedures

Responsibility Is Not Fixed

Although coordination of the constructibility review is the design PM's responsibility, this activity is normally assigned a low priority. This situation is unfortunate since a well executed review will normally find a number of significant errors that should be corrected prior to the construction bidding process. In addition, a completely reviewed design package will be a better product to turn over to a Construction Division.

The design package is forwarded to Construction Division for review (normally the Supervision and Inspection [S&I] Branch). The recipient then typically routes the package to technical review sections and the field. Often, the Construction Division focal point does not assume the responsibility to ensure that the reviews are completed and returned in a timely manner to the engineering PM. From his/her location in the Engineering Division, the PM cannot track or direct the progress of the review; thus, the quality and timeliness of the reviews are variable.

Prior Engineering Review Is Inadequate

A general consensus among workshop attendees was that often the design package submitted to Construction has not been reviewed. When this occurs, the constructibility effort is spent identifying problem areas that would normally have been found during Engineering technical reviews. Engineering's position on this problem is that since the design was completed late, the only feasible way to complete reviews is concurrently.

Coordinated Comments Are Not Given to A/Es

It appears that the review comments from various sources often are simply "bundled-up" and given to the A/E to review and incorporate as appropriate. It is unrealistic to expect the A/E to be able to decide the merits of all types of comments.

There Is Inadequate "Back-Check" of A/E Final Products

Typically, the A/E evaluates all comments received and incorporates those that are appropriate. An evaluation of the comments is normally submitted with the final design package. Often, Engineering does not adequately review the completed design package (back-check) to ensure that all review comments have been considered and incorporated as appropriate. Field personnel then note that the same design problem they observed and commented upon during the constructibility review is still in the design documents.

No Method of Sharing Lessons Learned Is Available

No method currently exists to share the locally developed expertise with regard to what to look for during a constructibility review. Each District has, over time, identified its recurring problem areas. These are addressed first during a constructibility review. The information on what to review tends to not be documented extensively so it is not easily transportable to another District.

District SOPs Are Not Always Developed

Not all Districts have developed detailed standard operating procedures (SOP) for conducting constructibility reviews. Districts that have tend to do a better review than those which have no SOP.

A/E Accessibility During Construction Varies

There is a significant variation in the A/E's involvement in answering questions during the construction process. Some field engineers call the A/E directly to obtain answers. At other Districts, the field engineer must go via an indirect route through the Engineering Division. Quick resolution of problems through this indirect route are very difficult to obtain.

Action Plan To Improve USACE BCO Activities

The results of the worksnop identified a three-step approach to improving the BCO process: revise ER 415-1-11, draft a Chief of Engineers Command Emphasis Letter, and identify automation opportunities. The first two items were completed in FY84; the third has resulted in the development of ARMS. The following chapters summarize actions taken to improve the review process.

4 REVISION OF ER 415-1-11

As a result of the BCO workshop at USACERL in June 1984, DAEN-ECC-Q (now CEEC-CE) drafted a revised ER 415-1-11. This regulation required the following:

1. A minimum of two BCO reviews are to be done: the first at the concept stage (at completion of feature design memorandum for civil projects) and the second at least 30 days prior to advertising.

2. Reviews should be done by a coordinated group of engineering, construction, and operation personnel.

3. The District Chiefs of Engineering and Construction will certify that all appropriate BCO comments have been incorporated into the bidding documents.

4. Performance of the Districts in completing BCO reviews will be evaluated.

The importance of this revision is that it recognizes that the successful completion of BCO review requires a coordinated effort between Construction and Engineering Divisions. The Certification Requirement forces this coordination and provides a check to ensure all comments have been addressed. This ER has recently been revised again (June 1988). The changes focus on further defining the roles of Chiefs of Construction, Engineering, and Contracting in ensuring that comprehensive, complete BCO reviews are completed.

5 TOP MANAGEMENT CONCERN FOR IMPROVED DESIGN REVIEW

Command Emphasis Letter

As a result of the USACERL BCO workshop, a command emphasis letter was drafted that tasked the USACE Divisions and Districts to fully address the following:

1. Districts Commanders should fully implement ER 415-1-11 and include BCO review activities as an important part of the review process.

2. Detailed BCO review procedures must be developed and implemented.

3. Adequate time must be allowed for BCO reviews. If design times are extended, delay of bid opening should be considered to provide adequate review time.

A copy of the letter is provided in Appendix C.

Corps of Engineers Blue Ribbon Panel

The 1983 findings of the Chief of Engineers Blue Ribbon Panel on Management of Construction Quality[7] found that BCO reviews and prebid conferences could be improved. The report stated that, in the drive to meet schedules, insufficient consideration is given to construction comments. Specifically suggested in the report was that a formalized system be established to resolve construction comments before advertisement (p 19 of that report). In addition, the study recommended that formal and informal communications be improved between Engineering and Construction Divisions.

These findings helped initiate development of ARMS which, as a design goal, would formally involve Engineering and Construction Divisions in the design review process. ARMS was also intended to ensure full documentation and timely response to all comments (Action Item 4.1 B) as well as provide a lessons-learned feedback system (Action Item 4.1 C).

Corps of Engineers Green Ribbon Panel

In a desire to improve USACE support activities to Army Installation Commanders, the Chief of Engineers directed, in 1984, the formation of a Green Ribbon Panel to identify methods of improvement. The report of this panel[8] identified several issues that have been solved by the present research effort.

Report Issue 7

Crosstalk between the DEHs and HQUSACE must be improved to allow for joint management. ARMS has addressed this need, providing for joint management of the review process. Using ARMS, DEH personnel can track the status of reviews as well as

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[7] *Report of Blue Ribbon Panel on: Management of Construction Quality in the U. S. Army Corps of Engineers* (USACE, 1983), p 12.

[8] *Report of the Green Ribbon Panel on: U.S. Army Corps of Engineers Support to Army Installation Commanders* (USACE, March 1985).

determine the performance of each individual reviewer. The date of receipt of action and number of remaining days to complete this action are provided for each level of user.

Report Issue 8

Both the quality of design review and feedback of design review problems need to be improved. The DEHs feel they are not as fully involved in the design review process as necessary. Review time is often short and resolution of comments they submit is not always made available to them. The system developed in this research directly addresses these DEH issues. ARMS is a formalized system that involves all levels participating in design review. All participants are identified on an equal level and can benefit from working together toward the common goal of quality design. Reviewers no longer work independently and can now access comments by others on the same project or similar ones. ARMS maintains complete records of all actions taken on a comment. This information is readily available to the comment originator. No longer will the commenter be uninformed as to the final disposition of his/her comment.

6 EXAMINATION OF USACE DESIGN REVIEW COMMENTS

In December 1984, a study was completed for USACERL under contract to analyze the quality and quantity of design review comments developed by USACE while reviewing A/E drawings and specifications for a sample of actual military facilities. (No results have been published.) The purpose of the study was to examine design review comments on various projects from two selected USACE Districts and categorize and analyze them by frequency of occurrence according to discipline, part of the facility, type of error, and various other design attributes.

A computer coding plan that would categorize each design review comment was prepared, tested, and evaluated using actual review comments from Sacramento District. A candidate list of projects from the Automated Military Progress Reporting System (AMPRS) and other data bases was prepared based on the availability of completed concept (35 percent) and final (95 percent) reviews. From the list, 28 different projects, consisting of nine different facility types, were chosen to ensure a representative overall sample (see Appendix D). After project selection, each District was visited. Over 2 weeks, the responsible PMs were interviewed and the various project files studied.

In all, more than 13,000 design review comments were made during the two reviews (concept, 35 percent, and final, 95 percent) for the 28 projects. The collection process consisted of reading each comment and coding it according to eight different categories (see Appendix E). An analysis of total comment frequency of occurrence in each of the eight categories yielded the following significant observations.

Category 1, Type of Facility, was divided into nine separate facility types. Each comment was then categorized by the facility type to which it pertained (Figure 2 and Appendix E). Although not totally representative of USACE's overall distribution of comments according to facility types, the comments are relatively dispersed and are shown to indicate the overall distribution of the project sample.

It is also important to note that of the 13,000+ comments examined, some 60 percent was submitted on the final design review (Figure 3). The higher percentage of comments on the 95 percent review can be attributed to the fact that, at this point, the contract document package would be nearly complete, resulting in a greater number of documents to be reviewed. Another reason could be that reviewers may wait until the final design review before giving their best effort to the project. In fact, during field visits by USACERL, reviewers sometimes mentioned that they wait until the final design review to comment.

When the comments were categorized according to where they were generated (Figure 4), it was found that more than 70 percent were submitted by the District Office. This finding is as expected since the main responsibility for reviews is at this level. A suprisingly low percentage of the comments, however, were submitted by the client/user and the DEH--a total of 8 percent. Since these organizations would typically generate most of the "operability" and "maintainablity" comments, it may be that these areas are not being addressed properly. The Field/Area Offices generated the lowest percentage of comments (1.7 percent).

The distribution of comments between topic areas of the comment's content was found to be similar to the distribution of USACE construction comments captured during the same timeframe in the CERS data base (Figure 5). The categories were selected in accordance with the Construction Specifications Institute (CSI) coding system; however,

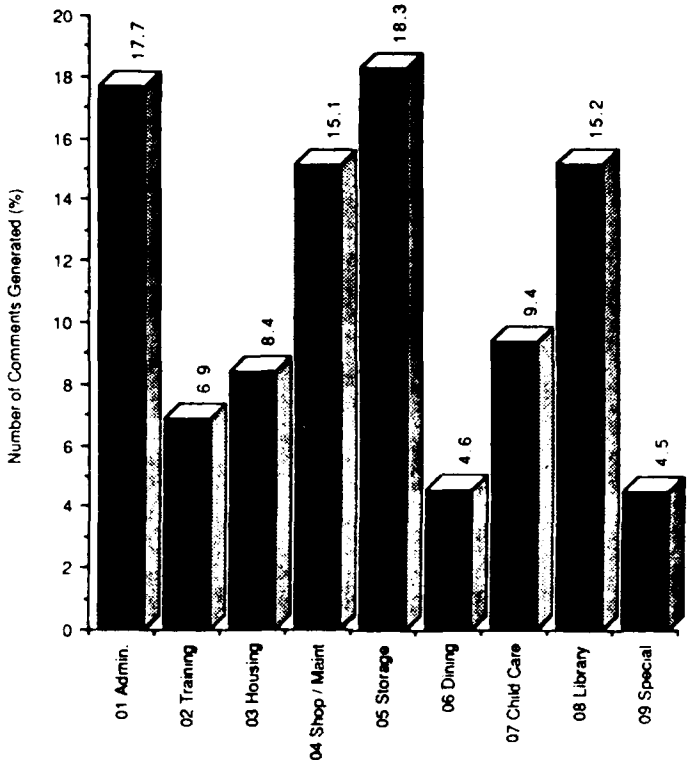

Figure 2. Type of facility distribution.

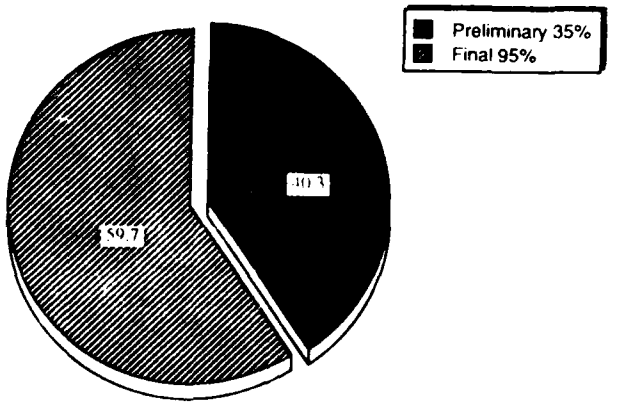

Figure 3. Distribution of comments according to review (percent).

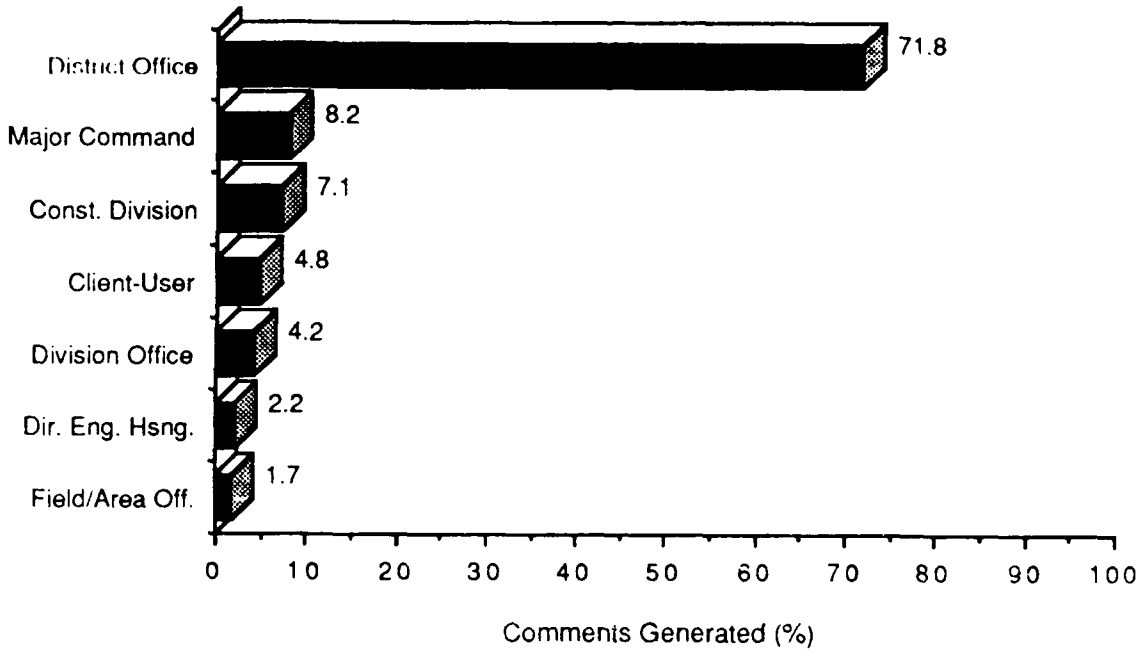

Figure 4. Distribution of comments by generator.

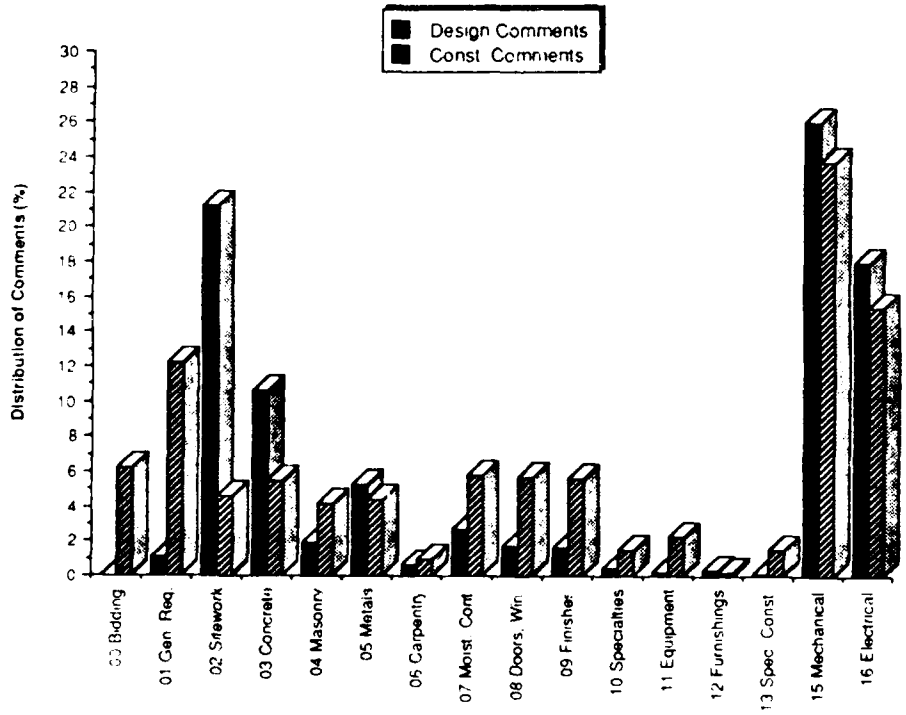

Figure 5. Comparison/distribution of comments by CSI coding.

not all comments were generated on specifications. Not surprisingly, more than half of all comments were categorized as related to either mechanical, electrical, or sitework--three areas where problems are most likely to occur. It is also notable that in some categories (e.g., sitework), the number of comments generated was significantly less during the construction review--an indication that this area is being addressed properly during the design review and at the design review conference. Conversely, mechanical and electrical comment percentages were high during both the design and the construction reviews. The reason for this finding should be the basis for a follow-on study.

Finally, all comments were examined and categorized according to the type of problem the comment addresses. More than 95 percent of all comments were found to address the area of coordination (Figure 6). This result leads to the conclusion that most review comments are not, as previously believed, to correct design deficiencies. Often, the reviewer makes a comment to suggest an alternative approach to the A/E, rather than a correction. The general review process, therefore, is not necessarily correction-oriented, but rather a cooperative venture in which the A/E and the reviewer work to provide the best possible project for the budget.

This observation also conflicts with the notion that a reduction in the number of comments on a review will suggest fewer design deficiencies in the project overall. In general, the number and frequency of comments do not bear a direct relationship to the number and kind of problems found in a design project. It was found that the overall number of comments is more closely related to external factors, such as the reviewer's workload, the complexity of the project, or the competence and experience of both the A/E and the reviewer--not just the technical aspects of the design. In many cases, design review comments were "instructions" for the next stage of design and gave a logical direction for the progress. Therefore, efforts should not be made to decrease the number of comments, but to increase the quality of comments generated.

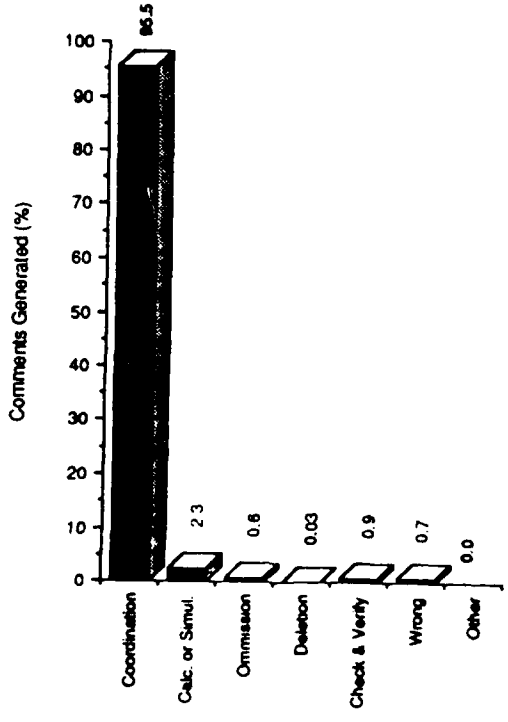

Figure 6. Problem type of review comment.

7 RECOMMENDATIONS FOR THE USACE DESIGN REVIEW PROCESS

USACERL consolidated the results of the questionnaire, onsite field visits, workshop results, and USACE Command interest to identify the areas that needed improvements in review management. The major problem noted with the existing USACE design and BCO reviews was the lack of an effective management system. The manual tracking process consisted of an overwhelming sequence of routing ledgers that clerical personnel were unable to keep current. The result was little, if any, management being exercised over personnel charged with executing the design reviews. It was concluded that a comprehensive tracking system could be instituted only via automation.

Five general areas of potential productivity improvement amenable to automated support were identified. Each area is summarized below.

Review Management and Tracking

The need to minimize the administrative burden on the design PM required that the processes of project implementation, review scheduling, and progress tracking of participating agencies be handled quickly and efficiently. Subordinate review managers faced similar scheduling and tracking problems in dealing with their reviewers. Existing methods of manual tracking usually involved maintaining a list of review assignments in each project file and required that managers periodically inspect these lists to determine when reviews were due. The lack of an up-to-date, comprehensive tracking system to constantly monitor design review due dates produced a hit-and-miss approach to review management and did little to foster on-time performance. The burden of timely compliance with the review request fell on equally busy review managers or reviewers who, aware of the inherent tolerances of the system, logically acted independently to complete tasks they felt were most pressing.

Comment Manipulation

With an average of 600 to 1000 comments per project, some 150 pages of handwritten (occasionally typed) comments would typically be submitted to the PM and forwarded to the architect. These comments had to be sorted, collated, and edited in order to organize them usefully by discipline, page number, or topic and to identify and extract duplicate comments from the package. In addition, comments were typically reviewed by clerks and the design PM to ensure completeness. Comments were clarified or amended by the PM, if appropriate. This editorial process could also involve retyping comments for legibility or because extra space was needed for amendments. In some cases, it might be necessary to telephone the reviewer for required comment information that was not provided initially. Finally, comments were organized as appropriate for use by the A/E and the package was reproduced and forwarded to the designer.

Feedback and Continuity

It was apparent that existing procedures were not providing for adequate feedback to reviewers on the ultimate disposition of their comments. This situation had several negative effects. First, the results of the review effort were never evident to the reviewers, which did little to bolster their morale. Second, the ability to conduct useful final and back-check reviews on completed design packages required that feedback from

earlier reviews be made available at that time. This step was especially important if different reviewers were to conduct the later reviews in order to maintain continuity in the effort. Finally, lack of ready access to the comment base for completed projects also inhibited development of useful lessons-learned mechanisms for various facility types. Lessons-learned feedback is essential to developing comprehensive checklists of potential problems for reviewers and contributes to better design guideline packages for submittal to A/Es.

Comment Resolution

A key element in improving design review effectiveness involved making the architect more responsive to the input generated from reviewers. Ensuring that comments were acted on by the A/E in a timely, appropriate manner required streamlining and formalizing the comment resolution process. In many instances, comments were not being incorporated properly into the revised construction documents. In cases where comments were contested by the A/E, the ultimate disposition of the comment was not documented. It is essential that such records exist since full and complete comment histories are critical in documenting subsequent E&O claims against the A/E.

Time Constraints

A widely expressed concern among survey participants was with the constant lack of time available for conducting the reviews. Although reviews were to be scheduled as an integral part of the design phase, the reality was that design phase completion dates were commonly slipped back into the review period. Since the ultimate ready-to-advertise completion date was seldom changed, the final and back-check review periods were severely constrained.

Certain time-consuming aspects were identified for improvement to maximize the time available for review. First, completed comments were typically sent by mail, which meant allocating 3 to 4 review days for returning comments to the District office. Second, the process of reviewing the comments for relevance, duplication, and completeness of thought was tedious since they were not readily organized by drawing number, discipline, or common topic. Finally, time was required to assemble comments submitted from various agencies into a cohesive, coherent, and usable package, as discussed under **Comment Manipulation** above.

Having recognized the extent of improvements achievable through automation, attention turned toward determining how existing computer technology could best be exploited in developing a workable system. By 1985, USACERL had defined the concept of automated support for the review process well enough to proceed with development of ARMS, a computer program envisioned to provide the efficiency needed for timely, proper completion of the review process. ARMS is described in detail in two other USACERL reports: a Draft Technical Report describing the field test and ADP P-87/08, the user's manual.

8 CONCLUSIONS AND RECOMMENDATIONS

USACERL has conducted an in-depth evaluation of the USACE design and BCO review processes. Weaknesses in the current manual review methods were identified through a USACE-wide survey; reports issued by USACE Green and Blue Ribbon Panels; and a follow-up workshop to pinpoint specific areas needing improvement. Four such areas were identified:

- Management emphasis
- Selection of A/Es
- Communication
- USACE procedures.

Based on these findings, remedial actions were recommended, which included revising ER 415-1-11, drafting a Chief of Engineers Command Emphasis Letter, and identifying potential benefits afforded by automation. The first two steps were completed during FY84; the third eventually resulted in the development of ARMS.

Based on these findings and the success of ARMS to date, it is recommended that all USACE activities responsible for constructibility and design reviews consider implementing the principles and technology described in this report. For further information, contact Mr. Jeff Kirby, USACERL, PO Box 4005, Champaign, IL 61820-1305, telephone (217) 373-7274 COMM, (800) USACERL outside Illinois or (800) 252-7122 within the state toll-free.

APPENDIX A:

ATTENDEES AT THE USACERL MEETING

The following persons attended the meeting at USACERL in June 1984 to define areas of improvement in the USACE review process and develop an action plan:

Attendees	Affiliation
R. Caraveau	Omaha District
D. Driggs	Galveston District
S. Green	HQUSACE
J. Kirby	USACERL
E. Lanier	Wilmington District
M. Maggi	Sacramento District
C. Meuter	Louisville District
M. O'Connor	USACERL
S. Olsen	Sacramento District
B. Vanstone	Walla Walla District

APPENDIX B:

FIELD SURVEY AND RESULTS

CONSTRUCTIBILITY REVIEW QUESTIONNAIRE

INTRODUCTION:

This questionnaire is part of a study of Constructibility Review procedures being conducted by the Construction Engineering Research Laboratory (CERL) for the Office of the Chief of Engineers (OCE). The objective is to determine the effectiveness of current procedures in improving the quality of construction contract documents and to recommend changes as needed.

Data will be summarized into a single Corps-wide report which will be used to evaluate the present effectiveness of Constructibility Review. Your name is needed only if you desire a copy of the survey's results. Names will not be associated with the survey data.

NOTE: You may not know the answer to some questions. When this happens check the "don't know" answer or do not check any response.

Completed questionnaires should be mailed to:

US Army Corps of Engineers
Construction Engineering Research Laboratory
ATTN: FS/Mr. G. E. Colwell
P.O. Box 4005
Champaign, IL 61820

DEFINITIONS:

A design deficiency is defined as any ambiguity, conflict, omission, error, etc., in the drawings or specifications requiring a contract modification to correct. (Requirement changes occurring after award, and differing site conditions are not considered design deficiencies.)

Constructibility Review as used in this questionnaire means a specific design review, prior to issuing the IFB, in which construction personnel participate with engineering personnel, architect/engineer personnel, and possibly user personnel to assure that the drawings and specifications are free of design errors, omissions, contradictions, and ambiguities; and that the documents can be understood, administered and enforced.

A. SCOPE OF THE PROBLEM

1. How would you characterize the number of design deficiencies occurring in Corps construction contract plans and specifications? (Q2)

(N=291)

14%	a.	Excessive and getting worse	12%
4	b.	Excessive but improving	3
30	c.	Somewhat excessive and getting worse	31
16	d.	Somewhat excessive but improving	18
10	e.	Acceptable but getting worse	12
14	f.	Acceptable and improving	13
3	g.	Satisfactory but getting worse	4
6	h.	Satisfactory and improving	6
3	i.	So few that they are not a problem	1

2. How would you characterize the number of contract modifications processed on Corps construction contracts? (Use the same scale as Question 1)

Enter response: (See above right) (N=281)

3. What percentage of all modifications processed are to correct design deficiencies? 56 % (N=253)

4. How accurate is this statement? "There is a correlation between the overall quality of construction workmanship and the number of contract modifications; e.g., workmanship deteriorates as modifications increase."

(N=293)

2%	Always true
36	Generally true
12	Don't know
41	Generally untrue
9	Absolutely untrue

B. CONSTRUCTIBILITY REVIEW METHODOLOGY

1. What effect has constructibility review (ER 415-1-11) had on the quality of contract drawings and specifications?

(N=288)

16% Greatly improved quality
65 Improved quality some
17 Very little improvement
2 No improvement

2. Has your Division or District Office provided any guidance or policy statement on the implementation of constructibility review procedures?

(N=280)

88% Yes
12 No

3. Is someone in your Division/District assigned the overall responsibility for implementing constructibility review procedures?

(N=261)

75% Yes
25 No (If "No", skip to Question 4)

3a. Is constructibility review a full-time job for that person?

(N=185)

31% Yes
69 No

3b. Who is that person's supervisor?

(N=187)

18% Chief, Engineering Division
60 Chief, Construction Division (or Con/Ops)
22 Other (specify) Chief S&I - Area Engineer - Chief QA Section

4. On the typical project, in how many design reviews do construction personnel participate; and at what stages of the design are these reviews performed?

(N=185)

2 Number of reviews
When between 35 & 60%
and between 90 & 100%

5. Does your District's plan require constructibility review for:

(N=266)

88% All projects
7 Only large, complex projects
5 Other (specify) military projects

6. Are minutes recorded of constructibility review meetings; particularly the comments for action? (N=245)

62% Yes
24 Usually
14 No

6a. Is there a record made of the follow-up disposition of comments? (N=260)

55% Yes
33 Usually
12 No

6b. Are those individuals who submitted comments advised of the action taken and supporting rationale? (N=284)

14% Always
37 Usually
33 Sometimes
14 Seldom
2 Never

7. If some projects are exempt from constructibility review, what is the criteria for making that determination? (N=79)

Time - Resources - Size of Project - Complexity of Project

8. For what percentage of projects is constructibility review performed by sending plans and specifications to reviewers rather than having a meeting? (NOTE: In responding to this question, don't include reviews performed during the advertising period. Constructibility review is to have been completed before the IFB is issued.) (N=262)

8%	0-10%	3	51-60%
2	11-20	2	61-70
3	21-30	8	71-80
2	31-40	14	81-90
3	41-50	54	91-100

8a. In cases where plans and specifications are distributed for constructibility review, how much time is allocated for review and submittal of comments? (N=282)

15% Less than 5 work days
17 About 5 work days
32 About 10 work days
22 About 15 work days
14 More than 15 work days

9. Who is responsible for scheduling constructibility review meetings and notifying those who are to attend? (N=214)

15% The same individual identified in question B3.
77 The Project Manager (Engrg Div) for that project.
8 Other (specify) Chief CON/OPS - No one - varies

10. Where are constructibility review meetings generally held? (N=226)

75%	District Office	2% 1&2
6	Architect/Engineer's Office	4 1&3
12	Other (specify)	1 1,2 &3

11. How many work days in advance are constructibility review meetings scheduled? (N=149)

Majority Between 5 & 10 days

12. Do those construction personnel who are scheduled to attend actually do so? (N=216)

21% Always
65 Most of the time
7 Less than one-half of the time
6 Seldom
1 Never

13. How often are personnel from construction field offices invited to participate in constructibility review meetings? (N=243)

19% Always
31 Most of the time
10 Less than one-half of the time
26 Seldom
14 Never

14. On an Architect/Engineer contracted design project with estimated construction cost of about $1.5 million, how many manhours of construction contract document review does the Corps normally expend? (N=40)

(Answer for your element only)	Horizontal Constr.	Vertical Constr.
Engineering Div. personnel	117	175
Construction personnel	26	32
Procurement personnel	10	15
Legal personnel	2	2

15. On the typical military construction project, how far in advance of formal advertising are the drawings and specifications completed and available for a final in-house review? (N=162)

19 Working days

16. How often is the number of discrepancies detected during the final constructibility review so great that it is impossible to issue addenda correcting all the discrepancies without postponing the bid opening date.

(N=267)

66% 0-20% of the time
16 21-40% of the time
11 41-60% of the time
3 61-80% of the time
4 81-100% of the time

17. How often is it necessary to proceed with the bid opening without having corrected all the known discrepancies in the plans and specifications?

(N=265)

3% 0% of the time
25 1-5% of the time
22 6-15% of the time
14 16-25% of the time
11 26-50% of the time
10 51-75% of the time
15 76-100% of the time

18. How often is the bid opening date postponed to allow issuance of addenda to correct discrepancies in the plans or specifications?

(N=282)

1% Always, regardless of the nature of the discrepancies.

12 Always, when the discrepancies are serious enough that failure to correct them by addenda would cause the need for a contract modification.

68 Sometimes, but only when the discrepancies are of a critical nature that would cause the need for a very costly and time consuming modification to the contract.

14 Almost never, because the bid opening date is a commitment that must be kept - the condition of the plans and specifications is never so bad as to justify postponing the bid opening date.

5 Other (please explain)

Only when consequences of not postponing greatly outweighs consequences of postponing.

C. CONSTRUCTIBILITY REVIEW EFFECTIVENESS

1. Does your District have any "before and after" statistics to show the results of its constructibility review efforts? (N=199)

13% Yes
87 No (skip to question 2)

1a. What do these statistics indicate has been the effect of constructibility review on the quality of contract documents? (N=21)

19% Greatly reduced deficiencies
57 Significantly reduced deficiencies
24 Slightly reduced deficiencies
____ No change

2. Considering the results obtained from your District's constructibility review efforts, how would you characterize the level of construction manpower being applied? (N=261)

2% Too much construction manpower applied - construction cost avoidance is too small to justify our in-house costs.

31 Construction manpower being applied is about right - construction cost avoidance exceeds our in-house costs.

61 More construction manpower is needed - we are not applying the resources needed to achieve the potential benefits of constructibility review.

6 Other (specify)
About right, but not enough time allowed for review - effort often wasted because comments not acted on

3. What effect does the fact that constructibility review manpower resources must be supported within the existing District organization have on implementing the program? (N=257)

9% Essentially prevents any real constructibility review - we just do not have the resource available.

68 Certainly prevents achieving the full potential of constructibility review - resources are not always available when needed.

18 No problem - we have managed to accomplish constructibility review to its full potential within our organization and manpower ceiling.

5 Other (specify)
Manpower problem compounded by fact that many more discrepancies are detected than are corrected by ADDENDA

4. Is the cost of implementing your constructibility review program offset by equal or greater cost avoidance in design deficiency modifications?

(N=282)

54% Yes
5 No
41 Do not know

5. Please rank the following disciplines as a source of design deficiencies. (Use scale of 1 through 5, with 1 indicating the worst offender.)

(N=284)

4 Civil
5 Structural
2 Architectural
1 Mechanical
3 Electrical

6. Do you believe that constructibility review as presented in ER 415-1-11 is a viable concept?

(N=254)

96% Yes
4 No

Comment: Haven't seen ER 415-1-11

D. QUALITY CONTRACT DOCUMENTS - RECOMMENDATIONS

1. To improve the quality of plans and specifications prepared by Architect/Engineer firms, the Corps needs to (check as many as required):

(N=291)

61% Be more discriminating in the selection of A/Es
54 Provide better guidance to A/Es
25 Pay the A/E more and/or allow more time
65 Do a better job of reviewing A/E products
76 Hold A/E firms liable for the cost of correcting their mistakes
1 No improvement is required - attempts at improvement would cost more than any benefits to be realized
0 None of the above
10 Other (specify)
Level the workload - avoid the end of FY crunch - allow enough time to do the job right

2. How valid is this statement? "In nearly all cases it is less costly to the Government (considering both in-house and construction contract costs) to correct discrepancies in the plans and specifications before bid opening than it is to correct them after award by contract modification."

(N=295)

81% Strong agree
15 Agree
1 Uncertain
2 Disagree
1 Strongly disagree

3. Do you believe that the Corps is overdoing the practice of revising drawings without reissue? (N=245)

13% Yes
36 Occasionally
51 No
Comment: Bad practice, we don't do it - only a minor revisions - often done because not enough time to reissue

4. Is the following assumption reasonable?

If the number of contract modifications were reduced, some of the construction field office manpower now assigned to modification processing could be reassigned to other duties, such as quality assurance and constructibility review. The long-range result would be that modifications resulting from design deficiencies would be further reduced and the effectiveness of quality assurance would be increased, with no change in overall field office manpower.

(N=288)

27% Strongly agree
44 Agree
16 Uncertain
11 Disagree
2 Strongly disagree
(Comment): Probably cause field office space allocation reduction

5. Do you believe that constructibility review as described in ER 415-1-11, if fully implemented and unconstrained by manpower limitations, would produce a significant improvement in Corps plans and specifications?

(N=284)

73% Yes
8 No
19 Don't know

6. The design background knowledge acquired through participation in constructibility review should enhance the decision-making ability of field personnel during construction. Would this benefit alone justify construction personnel's participation in design reviews?

(N=282)

77% Yes
15 No
8 Don't know
____ Comment: Both the construction and design personnel would benefit

7. Describe the ideal constructibility review team.

(N=202)

Discipline	No.	Full-time	Part-time	Experience
Civil Engr	1	53%	40%	5-10 yrs minimum
Architect	1	53%	40%	Both field & design
Mech. Engr	1	53%	40%	Experience, GS-12
Elect-Engr	1	53%	40%	Up-Knowledgable -
Constr. Rep.	1	53%	40%	From Constr. Site Office
-One for each major discipline involved -				
-Team should vary with nature of the project -				

8. At what points in the design process do you believe constructibility reviews should be conducted? (i.e., 35% design, 95% design).

(N=279)

1. 35% & 95%
2. 50% & 95%
3. 60% & 95%
4. 95% only
5. 30% & 50% & 95%
6. 25% & 75% & 95%

9. Constructibility review is one approach to improving the quality of the Corp's contract documents. Whether or not it is currently producing the anticipated improvements, constructibility review at its best may need to be supplemented with other actions. Please outline below what you would recommend to improve the quality of Corps contract documents and reduce the number of "design deficiency" modifications. (N=279)

Recommendations:

-More time for reviews - Hold A/Es liable for cost of correcting their mistakes - require A/E site visits - more manpower dedicated to review - more discrimating in A/E selection - do more inhouse design - use more experienced/qualified personnel for reviews - update guide specs to industry standards - more time for design - don't allow so many user criteria changes - involve more field personnel in reviews - create better "lessons learned" feedback - pay A/Es more and/or allow more design time - provide better guidance to A/Es - require designers to have field experience - furnish designers a list of repetitive construction deficiencies - blacklist unsatisfactory A/Es - don't open bids until all design corrections are made -

E. RESPONDENT PERSPECTIVE

NOTE: The following information will help us better understand your point of view and responses to this questionnaire. All information will be statistically averaged and presented in Corps-wide format. Your name will not be associated with the results in any way. (N=297)

1. What is your present assignment?

Counsel 1 Div. _____ Dist
Engineering 18 Div. 53 Dist
Construction 17 Div. 72 Dist 135 Field Office
Procurement 1 Div. _____ Dist
Other (specify) 2 (unidentified)

2. How many years of experience do you have in this type of work?

6 Years present assignment
18 Years total Corps
3 Years related private industry

3. What is your level of responsibility?

Grade 12.7
Series 810
Title Supv. Civil Engr.

4. Your name and mailing address are necessary only if you wish to receive a copy of the questionnaire results. Names will not be associated with results.

Name: _____

Address: _____

_____

_____

Phone: _____

SUMMARY OF RESPONSES

TO

CONSTRUCTIBILITY REVIEW

QUESTIONNAIRE

SOURCE	NUMBER	DIVISION		DISTRICT		
		ENGR	CONSTR	ENGR	CONSTR	FIELD
MRD	10	6	4			
MRK	17				5	12
MRO	28			7	8	13
NAD	4	1	3			
NAB	10			1	4	5
NAN	15			3	3	9
NAO	11			3	3	5
NAP	1			1		
NPD	4	3	1			
NPA	13			3	6	4
NPP	13			4	5	4
NPS	14			4	4	6
NPW	8			2		6
ORD	8	4	4			
ORH	9			1	5	3
ORL	9			2	1	6
ORN	6				4	2
ORP	4			3	1	
SAD	1		1			
SAC	4			1	1	2
SAJ	4			1		3
SAM	16			2	7	7
SAS	7			4	3	
SAW	4			1	2	1
SPD	2	2				
SPL	15			1	1	13
SPK	11				6	5
SPN	4			2	1	1
SWD	3(1)	1				
SWA	2				2	
SWF	1				1	
SWG	5			1	1	3
SWL	1				1	

SOURCE	NUMBER	DIVISION		DISTRICT		
		ENGR	CONSTR	ENGR	CONSTR	FIELD
SWT	4			2	2	
SW? (2)	31			3	4	24
TOTAL-	299 (1)	17	13	52	81	134

(1) Includes 1 Attorney and 1 Procurement Office

(2) SW? indicates responses received through Southwestern Division, from unidentified Districts and field offices.

APPENDIX C:

CHIEF OF ENGINEERS COMMAND EMPHASIS LETTER

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON D.C. 20314-1000

REPLY TO
ATTENTION OF

DAEN-ECC-Q 29 JUN 1984

SUBJECT: Biddability, Constructibility, and Operability Review Program

SEE DISTRIBUTION

1. The purpose of this letter is to task you to review and improve your Biddability, Constructibility, and Operability Review Program. Unfortunately, to date, most districts have not realized the significant cost avoidance potential of a well executed program. To ensure improvement, the effectiveness of your program, as defined in the recently revised ER 415-1-11, will be a performance review item.

2. Specifically, please ensure that your improved procedures fully address the following topic areas:

a. Command Emphasis: District Commanders should adopt a policy that biddability, constructibility, and operability are an important part of the design process because of the opportunity to avoid significant costs prior to construction and operation. District Commanders will fully implement ER 415-1-11 as recently revised.

b. Standard Operating Procedures: Those districts that do not have a detailed standard operating procedure (SOP) should develop one. The SOP should cover the following topic areas:

(1) Roles/Responsibilities. The respective roles and responsibilities of Engineering and Construction in the review process should be defined.

(2) Review Team Members. The organizational elements, disciplines and experience level of personnel included in a review team should be defined.

(3) Number of Reviews. The ER requirement of at least two reviews is important. More may be necessary or desirable. Field input at the concept state is extremely important and should not be delayed until the review just prior to advertising.

(4) In-House Design vs A/E Design. Your policy should assure that in-house design and A/E design will receive the same level of review.

(5) Concurrent Reviews. Your policy should assure that the technical review will precede the constructibility review. The biddability, constructibility, and operability review is not a substitute for full final design review.

c. Adequate time for constructibility reviews should be considered an integral part of the design process. Your policy must recognize the high relative importance of the review component in the design process. Initial planning must include adequate time for review. If the design process slips behind schedule, the review process should not be sacrificed. Wherever possible, the delay of bid opening should be considered in order to ensure adequate time for review.

3. By improving the biddability, constructibility, and operability review process, the Corps will be able to significantly improve the quality of our bid packages. This will reduce the necessity for contract modifications, and will improve the Corps' ability to deliver a quality product, on time, and within budget, which is our primary goal.

J. K. BRATTON
Lieutenant General, USA
Commanding

DISTRIBUTION:

COMMANDER:

EUROPE DIVISION
HUNTSVILLE DIVISION
LOWER MISSISSIPPI VALLEY DIVISION
MIDDLE EAST DIVISION
MISSOURI RIVER DIVISION
NEW ENGLAND DIVISION
NORTH ATLANTIC DIVISION
NORTH CENTRAL DIVISION
NORTH PACIFIC DIVISION
OHIO RIVER DIVISION
PACIFIC OCEAN DIVISION
SOUTH ATLANTIC DIVISION
SOUTH PACIFIC DIVISION
SOUTHWESTERN DIVISION
MEMPHIS DISTRICT
NEW ORLEANS DISTRICT
ST. LOUIS DISTRICT
VICKSBURG DISTRICT
MIDDLE EAST (REAR) DISTRICT
RIYADH DISTRICT
AL BATIN DISTRICT
KANSAS CITY DISTRICT
OMAHA DISTRICT
BALTIMORE DISTRICT
NEW YORK DISTRICT
PHILADELPHIA DISTRICT
BUFFALO DISTRICT
CHICAGO DISTRICT
DETROIT DISTRICT
ROCK ISLAND DISTRICT
ST. PAUL DISTRICT
ALASKA DISTRICT
PORTLAND DISTRICT
SEATTLE DISTRICT
WALLA WALLA DISTRICT
HUNTINGTON DISTRICT
LOUISVILLE DISTRICT
NASHVILLE DISTRICT
PITTSBURGH DISTRICT
FAR EAST DISTRICT
JAPAN DISTRICT
CHARLESTON DISTRICT
JACKSONVILLE DISTRICT
MOBILE DISTRICT
SAVANNAH DISTRICT
WILMINGTON DISTRICT
LOS ANGELES DISTRICT
SACRAMENTO DISTRICT
ALBUQUERQUE DISTRICT
SAN FRANCISCO DISTRICT
FORT WORTH DISTRICT
GALVESTON DISTRICT
LITTLE ROCK DISTRICT
TULSA DISTRICT

APPENDIX D:

PROJECTS ANALYZED FOR REVIEW COMMENTS AT SACRAMENTO AND BALTIMORE DISTRICT OFFICES

Sacramento

Code	Project	Spec. No.	FY	Bk.	Programmed $K
01	Academic/Instruction Facility, Ft. Huachuca, AZ	6658	85	--	5,550
02	Tac. Maint. Shops Ft. Irwin, CA	5994	81	46c	9,825
03	Brigade HQ Admin. Ft. Huachuca, AZ	6248	84	15c	1,110
04	CE Test and Eval. Facility	6507	85	58a	3,450
05	Class I Storage	6602	85	47a	1,489
06	Child Care Center Presidio, SF	6663	85	8f	3,166
07	BOQ Ft. Irwin, CA	6499	85	46b	5,444
08	Dining Facility Modern. - Monterey, CA	6358	85	54b	1,509
09	Core Instrument Facility - Ft. Irwin, CA	6700	84	60b	4,526
10	Academic Library Monterey, CA	6676	84	62a	1,400
11	Admin./Supply Facility	6831	85	62a	10,000
12	Physical Fitness Complex - Monterey, CA	6736	84	62a	10,000
13	Barracks-Phase II Monterey, CA	6580	84	61b	14,300

Baltimore

14	Chapel and Child Care Facility	PN 118	85		4,950
15	NASA-Special Process Laboratory	PN 4649-1	84		40,000

Code	Project	Spec. No.	FY	Programmed $K
16	Satellite Facility	PN 231	83	1,200
17	Enlisted Barracks Phase II	1331	84	9,800
18	CSM Medical Res. Lab.	NAB-MC	84	3,650
19	Commisary/Warehouse Ft. Meade, MD	Eny	84	11,200
20	Fire Station, Ft. Detrick, MD	Rowe	84	1,160
21	Tri-Service Med. Facility	Rowe	85	2,750
22	Medical Info. and Intell. Facility	Rowe	85	3,600
23	Satellite Control Facility Ft. Detrick, MD	Rowe 197	83	1,700
24	Communications Center Ft. Detrick, MD	Rowe 198	84	1,650
25	Movement and Handling Facility - Tobyhanna, PA	Oler 56	84	9,200
27	Army Reserve Center Lewistown, VA	Oler 178	85	2,503
28	Warehouse Facility, Gr. Pittsburgh, PA	Oler 50011	85	1,246

APPENDIX E:

CODING CATEGORIES

1. Project Type Distribution
   02 Training
   03 Housing
   04 Shop/Maint.
   05 Storage
   01 Administrative
   07 Child Care
   08 Library
   09 Special
   06 Dining

2. Design Package Distribution
   02 Plans - Mech
   03 Plans - Struct
   04 Plans - Civil
   05 Plans - Elec
   06 Plans - Other
   07 Specs - General
   08 Specs - Special
   01 Plans - Arch
   10 Specs - Tech Sections
   11 Cost Est - Arch
   12 Cost Est - Mech
   13 Cost Est - Struct
   14 Cost Est - Civil
   15 Cost Est - Other
   16 Inst to Bidders
   09 Specs - General

3. Comment Originator Distribution
   02 Engr Div
   03 Const Div
   04 Field Office
   01 District
   06 DEH
   07 MACOM
   05 Client User

4. Comment Type
   02 Functional
   03 Biddability
   04 Constructibility
   01 Technical
   06 Maintainability
   07 Coordination
   05 Operability

5. Design Stage Distribution
   02 Final Design or 95%
   01 Concept or 35%

6. CSI Category Code Distribution
   01 General Requirements
   02 Sitework
   03 Concrete
   04 Masonry
   05 Metals
   06 Carpentry
   07 Moisture Control
   08 Doors, Windows, Glass
   00 Bidding
   10 Specialties
   11 Equipment
   12 Furnishings
   13 Spec Construction
   14 Conveying Sys.
   15 Mechanical
   16 Electrical
   17 Special/Functional
   09 Finishings

7. Problem Distribution
   02 Calcs. or Simulation
   03 Omission
   04 Deletion
   01 Coordination
   06 Wrong/Incorrect
   07 Other
   05 Check and Verify

8. Bldgs. Sys. Index Distribution
   - 01 Substructure
   - 02 Structural Frame
   - 03 Roofing
   - 04 Exterior Closure
   - 05 Interior Construction
   - 06 Interior Finishes
   - 07 Specialties
   - 08 Plumbing
   - 09 HVAC
   - 10 Spec. Mech Sys.
   - 11 Electrical
   - 12 Spec. Elec. Systems
   - 13 Equip. and Conveying
   - 14 Site Prep
   - 15 Site Improvements
   - 16 Site Utilities
   - 17 Spatial/Functional

USACERL DISTRIBUTION

Chief of Engineer
ATTN: CEEC-CE
ATTN: CEIM-SL (2)
ATTN: CECC-P
ATTN: CECW
ATTN: CECW-O
ATTN: CECW-P
ATTN: CECW-RR
ATTN: CEEC
ATTN: CEEC-C
ATTN: CEEC-E
ATTN: CERD
ATTN: CERD-C
ATTN: CERD-M
ATTN: CERM
ATTN: DAEN-ZCE
ATTN: DAEN-ZCI
ATTN: DAEN-ZCM
ATTN: DAEN-ZCZ

CEHSC
ATTN: Library

US Army Engineer Districts
ATTN: Library (41)
Alaska 99506
ATTN: NPAEN-PL
Galveston 77550
ATTN: CESWGCO
Louisville 40201
ATTN: CEORLCD-I
Omaha 68102
ATTN: CEMROCD-CR
Sacramento 95814
ATTN: CESPKEN-DQA
ATTN: CESPKRV
Walla Walla 99362
ATTN: CENPWCP
Wilmington 28401
ATTN: CESAWEN-D

US Army Engr Divisions
ATTN: Library (13)

US Army Europe
ODCS/Engineer 09403
ATTN: AEAEN-FE
ATTN: AEAEN

USA Japan (USARJ)
ATTN: DCSEN 96343

Area Engineer, AEDC-Area Office
Arnold Air Force Station, TN 37389

416th Engineer Command 60623
ATTN: Facilities Engineer

US Military Academy 10966
ATTN: Dept of Geography & Computer Science

AMC - Dir., Inst., & Svcs.
ARRADCOM 07801
ATTN: DRDAR-PSE

DLA ATTN: DLA-WI 22304

DNA ATTN: NADS 20305

FORSCOM
FORSCOM Engineer, ATTN: Spt Det.

HSC
Ft. Sam Houston AMC 78234
ATTN: HSLO-F
Fitzsimons AMC 80045
ATTN: HSHG-DEH
Walter Reed AMC 20307
ATTN: Facilities Engineer

USA AMCCOM 61299
ATTN: AMSMC-RI
ATTN: AMSMC-IS

Military Traffic Mgmt Command
Falls Church 20315
Oakland Army Base 94626
Bayonne 07002
Sunny Point MOT 28461

NARADCOM, ATTN: DRDNA-F 01760

TARCOM, Fac, Div. 48090

TRADOC
HQ, TRADOC, ATTN: ATEN-DEH 23651

TSARCOM, ATTN: STSAS-F 63120

USAIS
Fort Huachuca 85613
ATTN: Facilities Engineer (3)
Fort Ritchie 21719

WESTCOM
Fort Shafter 96858
ATTN: DEH
ATTN: APEN-A

HQ USEUCOM 09128
ATTN: ECJ 4/7-LOE

CECRL, ATTN: Library 03755

WES, ATTN: Library 3918

NAVFAC
ATTN: Division Offices (11) 22332
ATTN: Facilities Engr Cmd (9)
ATTN: Naval Civil Engr Lab (2)

NCEL 93043
ATTN: Library (Code L08A)

Engineering Societies Library
New York, NY 10017

US Government Printing Office 22304
Receiving/Depository Section (2)

US Army Env. Hygiene Agency
ATTN: HSHB-ME 21010

Nat'l Institute of Standards & Tech 20899

Defense Technical Info. Center 22314
ATTN: DDA (2)